

CLAIMS

[1] A piezo-electric actuator comprising:

a piezo-electric element having a piezo-electric body which is
5 provided with at least two opposing surfaces, wherein the surfaces perform an
expanding and contracting motion in accordance with a state of an electric
field;

a constraint member for constraining the piezo-electric element on
at least one of the two surfaces,

10 a supporting member disposed around the constraint member, and
a plurality of beam members each having both ends that are fixed to
the constraint member and the supporting member, respectively, wherein each
beam member has a neutral axis for bending in a direction substantially parallel
with the constrained surface,

15 wherein the constraint member vibrates by vibration which is
generated by constraining effect between the constraint member and the
piezo-electric element, and is amplified by the beam members.

[2] The piezo-electric actuator according to claim 1, wherein said beam
20 members are straight beams.

[3] The piezo-electric actuator according to claim 1 or 2, wherein said
constraint member has a base for constraining said piezo-electric element; and
a plurality of arms that extend from said base to constitute said beam
25 members.

[4] The piezo-electric actuator according to any of claims 1 to 3,
wherein said constraint member is a second piezo-electric element which
differs in vibrating direction from said piezo-electric body.

5 [5] The piezo-electric actuator according to any of claims 1 to 3,
wherein said piezo-electric element comprises a plurality of said piezo-electric
bodies and a plurality of electrode layers for applying an electric field to said
piezo-electric bodies, wherein each piezo-electric body and each electrode
layer is alternately laminated.

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[6] The piezo-electric actuator according to any of claims 1 to 5, wherein said
piezo-electric element is provided with an insulating layer on at least one of
said two surfaces.

15 [7] The piezo-electric actuator according to any of claims 1 to 6,
wherein said piezo-electric element has a rectangular parallelepiped shape.

[8] An acoustic element comprising:
the piezo-electric actuator according to any of claims 1 to 7; and
20 a vibrating film coupled to said piezo-electric actuator for radiating
sound through vibration that is transmitted from said piezo-electric actuator.

[9] The acoustic element according to claim 8, further comprising a
vibration transmitting member sandwiched between said piezo-electric actuator
25 and said vibrating film.

[10] An electronic device comprising the piezo-electric actuator according to any of claims 1 to 7.

5 [11] An electronic device comprising the acoustic element according to claim 8 or 9.

[12] An acoustic apparatus comprising a plurality of said acoustic elements according to claim 8 or 9 which have resonance frequencies different from each other for smoothing frequency response of sound pressure.

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[13] An electronic device comprising said acoustic apparatus according to claim 12.